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DETECTING DIFFERENTIAL ITEM FUNCTIONING IN 2019 BECE BASIC SCIENCE MULTIPLE CHOICE ITEMS ADMINISTERED IN SCHOOLS IN RIVERS STATE, NIGERIA

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ABSTRACT

The study investigated items of 2019 basic science multiple choice, basic education certificate examination (BECE), conducted by the Rivers state ministry of education for junior secondary school three certification. The study attempted to detect differential item functioning of the administered items on urban and rural JSS3 students in Rivers State. A sample size of 240 students drawn from the entire JSS3 population in the state using multistage random sampling technique were used for the study; 120 from urban and 120 from rural schools. Comparative research design was adopted as the framework in this study. The 60 multiple choice 2019 basic science BECE items were used as instrument for data collection which were administered to the students. Items were dichotomously scored. R software was used for item analysis to determine difficulty and discrimination parameters in Two Parameter Logistic Model (2PLM) of Item Response Theory (IRT). R was also adopted to detect deferentially functioning items using Mantel-Haenszel DIF detection method. The study compared results between urban and rural students item characteristic curves, parameters, chi-square statistics, and p-values. It was discovered that urban students found more of the 2019 basic science BECE items easier than their counterparts in the rural areas. The study also revealed that some items deferentially functioned between the two groups when used to assess them. Based on the findings, it was recommended that basic science items for such assessment should be thoroughly checked for DIF, and if found, eliminated or edited before use. Both urban and rural students should be placed on the same condition of learning.

KEYWORDS: ***Item Response Theory, Differential Item Functioning***

INTRODUCTION

Students in junior secondary schools are given certification examination at the end of their three years academic programme. This examination, known as Basic Education Certificate Examination (BECE) or Junior School Certificate Examination (JSCE), is conducted by the Rivers State Ministry of Education for all junior secondary school three (JSS3) students in public and private schools in Rivers state. This examination is in accordance with the 6-3-3-4 education policy in Nigeria.

The Rivers State Ministry of Education (MOE) assess students on the basic education subjects and certify them to proceed to the next level (Senior Secondary School). The certification is based on the number of credit passes obtained. Students are expected to pass six subjects including English language, mathematics, basic science, business studies, etc. This criterion is set as the standard to evaluate all students from the different regions (rural, semi-urban and urban), socioeconomic disposition of parents/guardians, teaching strength and aids available in schools. The BECE being conducted on only the cognitive domain also calls for concern.

The BECE is a high stake and a large scale test. The items used in all the subjects should have stable psychometric dimensions. Items parameters such as difficulty discrimination and guessing indices should remain constant during assessment of both rural, semi-rural and urban subgroups of students. Change in these items characteristics during assessment is referred to as differential item functioning (DIF). This change negate the invariance assumption of item response theory (IRT), which states that item parameter indices should remain the same for subgroups of the same population during assessment (Goldstain, 1983; Wollack, Sung & Kang; 2006; Li, 2008).

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DIF (uniform and non-uniform) and item parameter drift (IPD) are almost similar concepts. Both are violations of the item parameter invariance assumption of IRT. DIF explains change in item characteristics when samples of the same population are measured repeatedly with the same instrument (Pine, 1977; Goldstein, 1983; Bock, Muraki & Pfeiffenberger, 1988; Holland & Wainer, 1993; Wollack, Sung & Kang; 2006). IPD explains the change in item parameter indices at different times or occasions of testing individuals of the same ability on a task. This difference can lead to lowering of reliability and validity of tests, as well as biases in person and parameter estimation (Babcock & Albano, 2011; Bulut, Stanke, Rodriguez, Palma Vue, & Cabrera, 2013).

All students progressing from JSS1 through JSS3 are bound to pass through differing emotional, physical and socioeconomic experiences in and outside the classrooms, which in turn may modify their character. Strength and styles of instruction adopted for teaching and learning in the different school settings, the types and number of teaching aids available in the various schools, and the level of supervision of learning activities are not the same in the schools across the state. These may lead to different experiences in students of the same level.

The plethora of differences in the learners, learning methods, environmental and social dispositions were the factors that aroused the researcher's interest. This study empirically investigated the number of items present in 2019 basic science objective items that exhibited difference in difficulty and discrimination parameters.

In the course of this study, the researcher intended to ascertain the presence of DIF items in the 2019 basic science BECE conducted by ministry of education in Rivers State. The following research questions and hypothesis were formed to guide this study.

RESEARCH QUESTIONS.

1. To what extent do items of 2019 basic science BECE differ in difficulty indices during testing between rural and urban JSS3 students in Rivers State?
2. To what extent do items of 2019 basic science BECE differ in discrimination indices during testing between rural and urban JSS3 students in Rivers State?
3. How many items of 2019 basic science BECE are DIF items?

HYPOTHESIS.

1. There are no DIF items of 2019 basic science BECE.

METHODOLOGY

Sample: All the JSS3 students in both private and public schools formed the population of this study. A total of 12 schools were randomly selected for the study using stratified random sampling; six from urban and six from rural. A total of 20 students were also randomly selected from each of the 12 schools. So, the total number of the students used for this study was 240; 120 from rural schools and 120 from urban schools.

Instrument for Data Collection

The 2019 Rivers State MOE BECE Basic Science objective (section A) items were used for the study. This had 60 multiple choice items. These items were administered to JSS3 students in a normal classroom examination setting in their schools. Items were dichotomously scored (1 for correct and 0 for incorrect) thereafter.

Analysis

After items were dichotomously scored, R software was used to determine difficulty (b) and discrimination (a) parameters. Two-parameter logistic model (2PLM) of IRT was adopted in the analysis and the associated packages were used in the item parameter analysis. This was because the packages provided a framework for IRT analyses for dichotomous data under a marginal Maximum Likelihood approach (Rizopoulos, 2006).

Difficulty and discrimination parameter analyses were carried out using on the dichotomously scored items using ltm package. Other R packages were also used to detect DIF in the items. Some methods of DIF detection are Transformed Item Difficulty (TID), Mantel-Haenzel, Standardization, Logistic regression, Breslow-ay, Lord Chi-square test and Raju's area methods. The item characteristic curve showed the plots of all the 60 items.

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RESULTS

b *is Difficulty parameter,* ***a*** *is Discrimination parameter.*

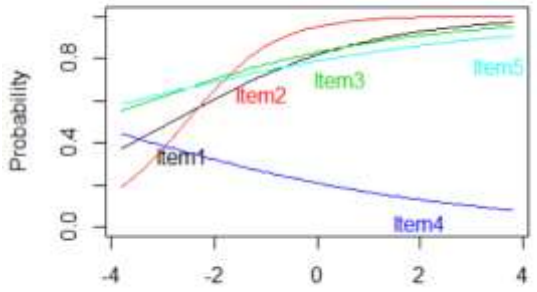

Fig. 1

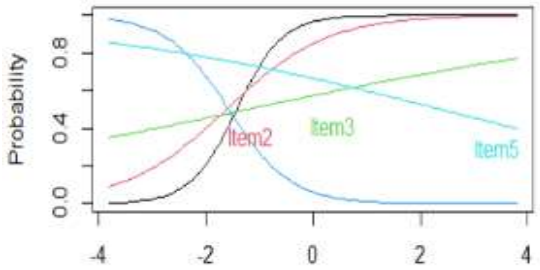

Fig. 2

	b	a
Item1	-2.8292	5.2503
Item2	-2.5526	1.1461
Item3	-4.3910	3.5774
Item4	-4.6183	-2.8665
Item5	-5.1213	2.5494

	b	a
Item1	-1.4245	2.3428
Item2	-1.6206	1.0691
Item3	-1.2315	0.2408
Item4	-1.5736	-1.7327
Item5	2.3952	-0.2868

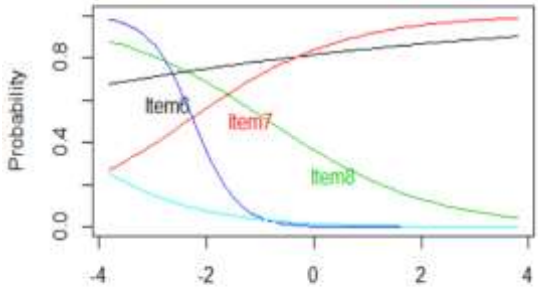

Fig. 3

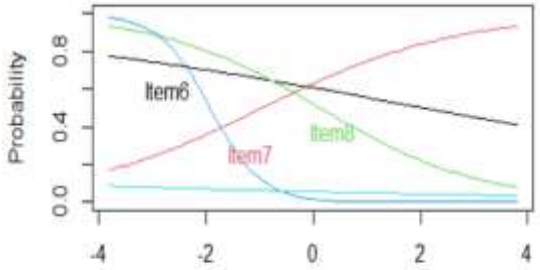

Fig. 4

	b	a
Item6	-7.6270	1.9287
Item7	-2.3460	6.9116
Item8	-8.2396	-6.6373
Item9	-2.2304	-2.4629
Item10	-5.1644	-7.8620

	b	a
Item6	2.0669	-0.2112
Item7	-0.9459	0.5549
Item8	0.1339	-0.6674
Item9	-1.9204	-2.0946
Item10	-22.8480	-0.1229

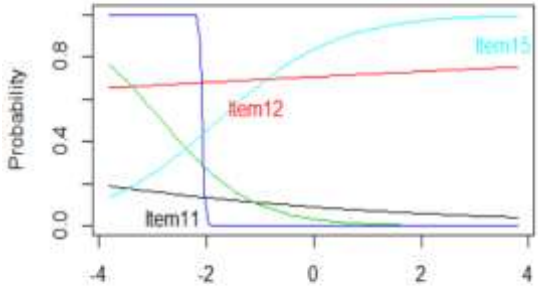

Fig. 5

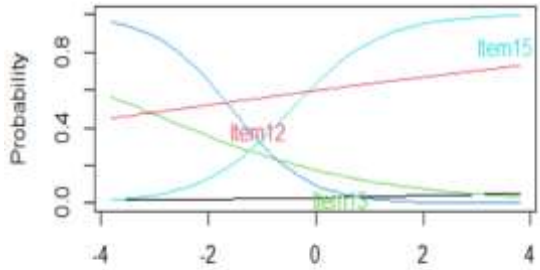

Fig. 6

	b	a
Item11	-1.0325	-2.2339
Item12	-1.3999	6.2154
Item13	-2.8330	-1.1906
Item14	-2.0715	-4.5074
Item15	-1.7689	9.0927

	b	a
Item11	21.6440	0.1605
Item12	-2.5372	0.1557
Item13	-3.2333	-0.4735
Item14	-1.5625	-1.4140
Item15	-0.4408	1.2085

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b *is Difficulty parameter,* ***a*** *is Discrimination parameter*

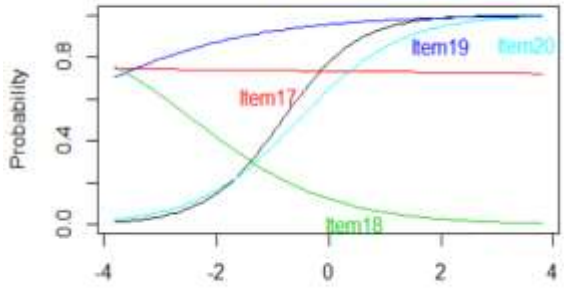

Fig. 7

	b	*a*
Item16	*-8.2316*	*1.4901*
Item17	*6.5660*	*-1.5327*
Item18	*-2.4052*	*-8.1601*
Item19	*-5.2853*	*5.7887*
Item20	*-5.2983*	*1.1146*

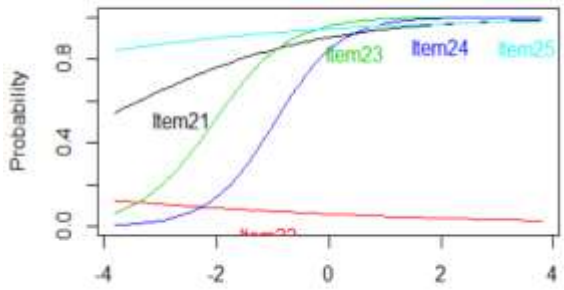

Fig. 9

	b	*a*
Item21	*-4.1145*	*5.4023*
Item22	*-1.3041*	*-2.1029*
Item23	*-2.0468*	*1.5121*
Item24	*-9.5741*	*1.7398*
Item25	*-9.2620*	*3.0303*

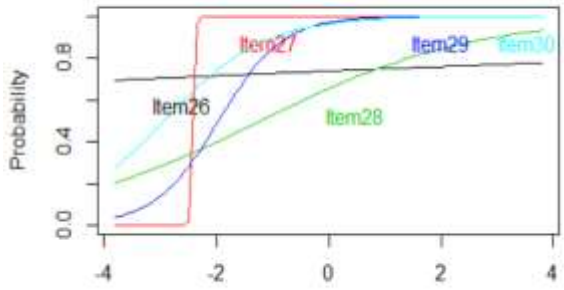

Fig. 11

	b	*a*
Item26	*-1.8266*	*5.6520*
Item27	*-2.4127*	*4.6570*
Item28	*-1.2077*	*5.2233*
Item29	*-1.9610*	*1.7578*
Item30	*-2.9305*	*1.1127*

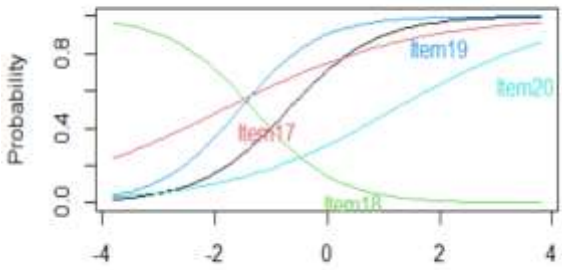

Fig. 8

	b	*a*
Item16	*-0.6899*	*1.2747*
Item17	*-1.8500*	*0.5928*
Item18	*-1.3081*	*-1.3487*
Item19	*-1.5617*	*1.4157*
Item20	*1.1857*	*0.6810*

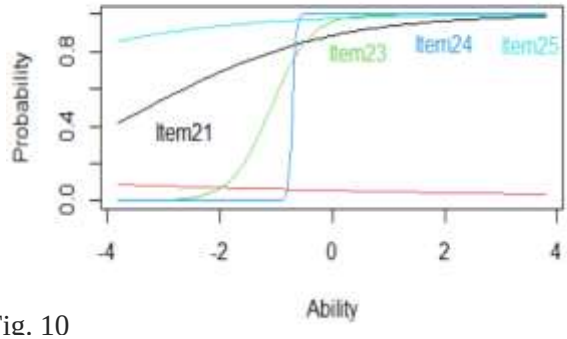

Fig. 10

	b	*a*
Item21	*-3.2824*	*0.6214*
Item22	*-22.2117*	*-0.1265*
Item23	*-1.0885*	*2.8744*
Item24	*-0.7064*	*35.0288*
Item25	*-7.2176*	*0.5180*

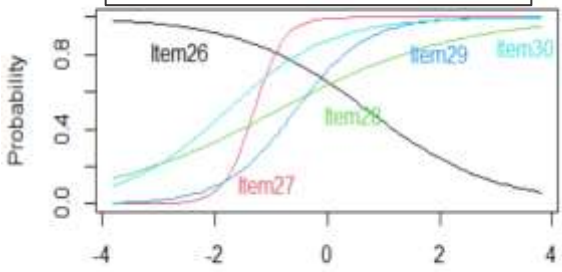

Fig. 12

	b	*a*
Item26	*0.7290*	*-0.8807*
Item27	*-1.3012*	*3.7751*
Item28	*-0.8828*	*0.6274*
Item29	*-0.5663*	*1.5934*
Item30	*-1.7817*	*1.0895*

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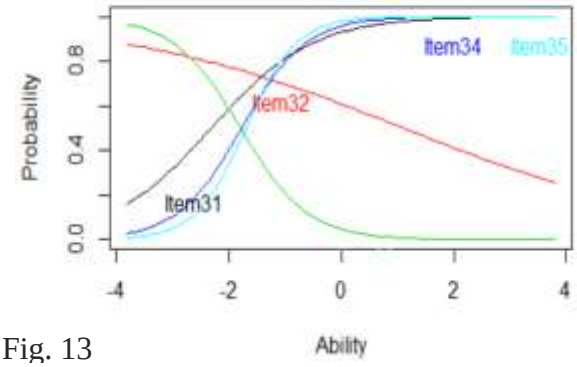

Fig. 13

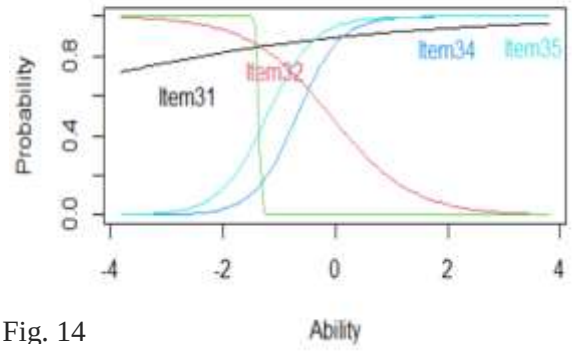

Fig. 14

	b	a
Item31.	-2.3086.	1.1081
Item32	1.1110	-3.9669
Item33	-1.7902	-1.6725
Item34	-1.7718	1.7462
Item35	-1.6915	2.2369

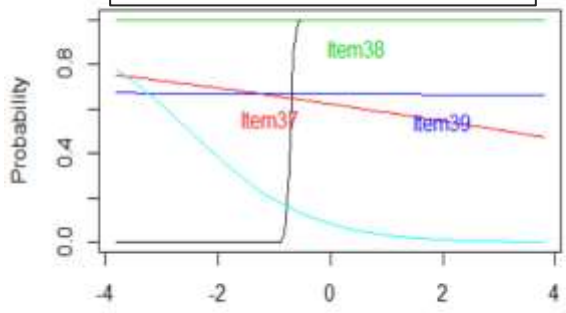

Fig. 15

	b	a
Item31	-6.8226	0.3117
Item32	-0.0829	-1.3753
Item33	-1.3555	-52.1688
Item34	-0.6812	2.6304
Item35	-1.2114	2.3958

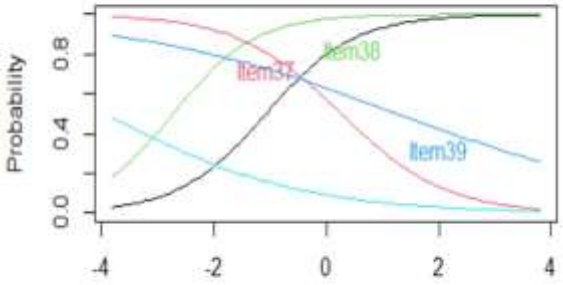

Fig. 16

	b	a
Item36	-7.0704	3.2328
Item37	3.1140	-1.5947
Item38	2.1567	-3.0402
Item39	1.2193	-5.6687
Item40	-2.4941	-9.4867

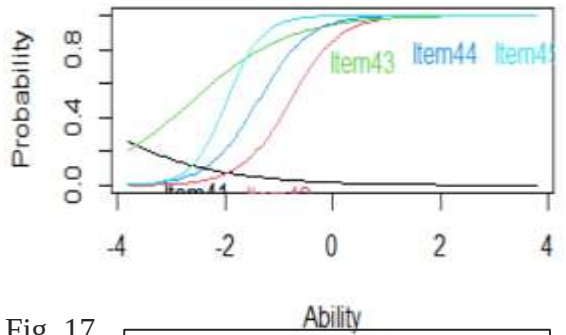

Fig. 17

	b	a
Item41	-5.1644	-7.8620
Item42	-7.9233	2.2169
Item43	-2.5939	1.1083
Item44	-1.3803	2.2009
Item45	-1.9543	3.0956

	b	a
Item36	-1.0695	1.2705
Item37	0.2732	-1.0810
Item38	-2.7213	1.3716
Item39	1.2850	-0.4159
Item40	-3.9216	-0.5811

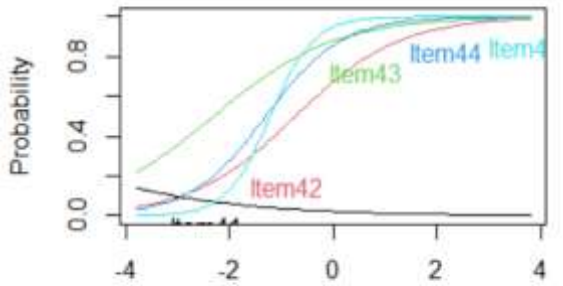

Fig. 18

	b	a
Item41	-7.3555	-0.5074
Item42	-0.7301	0.9893
Item43	-2.3104	0.8529
Item44	-1.3009	1.3677
Item45	-1.2114	2.3950

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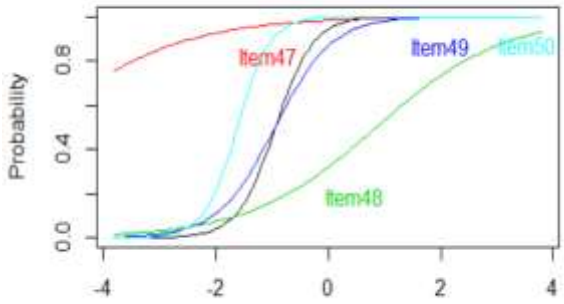

Fig. 19

	b.	. a
Item46	-9.3421	3.0031
Item47	-5.2662	7.6587
Item48	8.6065	8.8221
Item49	-9.4457	1.9828
Item50	-1.6190	3.4285

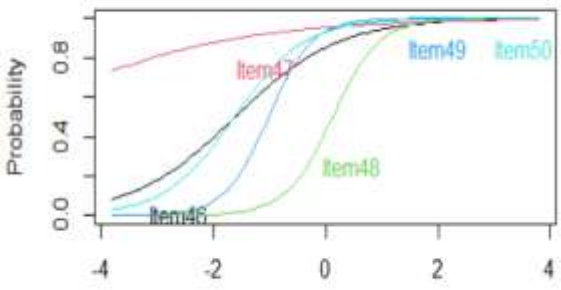

Fig. 20

	b	a
Item46	-1.6045	1.0893
Item47	-5.6947	0.5297
Item48	0.1242	2.4240
Item49	-1.0162	2.6003
Item50	-1.6232	1.6056

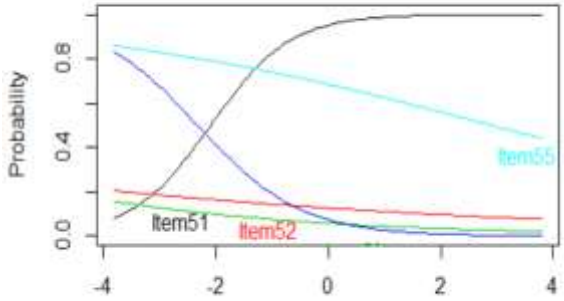

Fig 21

	b	a
Item51	-2.0889	1.4216
Item52	-1.2856	-1.5070
Item53	-9.5780	-2.9219
Item54	-2.3285	-1.0878
Item55	2.8992	-2.6797

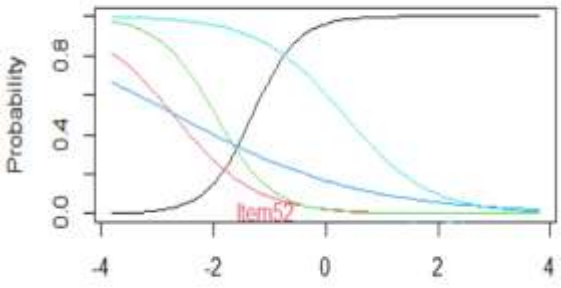

Fig. 22

	b	a
Item51	-1.3007	2.4752
Item52	-2.7127	-1.3785
Item53	-1.9646	-1.9884
Item54	-2.6665	-0.6007
Item55	0.3275	-1.3277

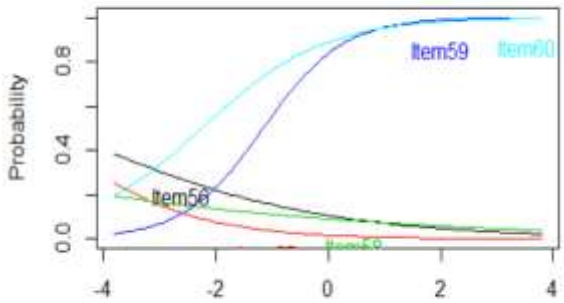

Fig. 23

	b	a
Item56	-4.8829	-4.3656
Item57	-5.1643	-7.8620
Item58	-9.9298	-2.3287
Item59	-1.1542	1.4130
Item60	-2.2465	9.2354

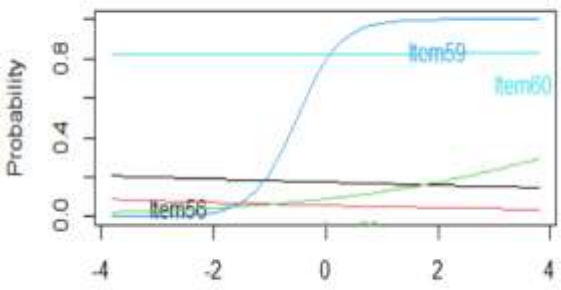

Fig. 24

	b	a
Item56	-28.6012	-0.0543
Item57	-22.8480	-0.1229
Item58	6.0938	0.3808
Item59	-0.5085	2.5870
Item60	-248.9673	0.0062

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Mantel-Haenszel Chi-square statistic:

	Stat.	P-value
Item1.	0.2707	0.6029
Item2.	0.0208	0.8852
Item3.	2.9442	0.0862.
Item4.	0.2806	0.5963
Item5.	1.9895	0.1584
Item7.	0.0127	0.9101
Item8.	4.1932	0.0406 *
Item9.	0.0408	0.8399
Item10	0.1250	0.7237
Item11	0.0000	1.0000
Item12	4.0497	0.0442 *
Item13	0.2576	0.6118
Item14	3.7448	0.0530.
Item15	0.1184	0.7308
Item16	0.7339	0.3916
Item17	2.0518	0.1520
Item18	1.6456	0.1996
Item19	0.5901	0.4424
Item20	0.0667	0.7963
Item21	Inf	0.0000 ***
Item22	Inf	0.0000 ***
Item23	3.9750	0.0462 *
Item24	0.0068	0.9340
Item25	Inf	0.0000 ***
Item26	1.7410	0.1870
Item27	0.0000	1.0000
Item28	0.1557	0.6931
Item29	0.2361	0.6271
Item30	0.1889	0.6638
Item31	0.0781	0.7799
Item32	0.1565	0.6924
Item33	0.1468	0.7016
Item34	0.0006	0.9813
Item35	0.0310	0.8602
Item36	0.0244	0.8759
Item37	0.0086	0.9261
Item38	0.0208	0.8852
Item39	0.1815	0.6701
Item40	0.1167	0.7326
Item41	0.1250	0.7237
Item42	0.3889	0.5329
Item43	0.0009	0.9761
Item44	0.1142	0.7354
Item45	0.3125	0.5762
Item46	3.7902	0.0516
Item47	0.3452	0.5569
Item48	0.1565	0.6924
Item49	1.2380	0.2658
Item50	0.5901	0.4424
Item51	0.3333	0.5637
Item52	0.0408	0.8399
Item53	1.5610	0.2115
Item54	0.0669	0.7960
Item55	0.6403	0.4236
Item56	0.0669	0.7960

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Item57	0.1250	0.7237
Item58	0.1250	0.7237
Item59	0.1789	0.6723
Item60	0.0984	0.7537

Significant. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Detection threshold: 3.8415 (significance level: 0.05)

Items detected as DIF items:

Item8
Item12
Item21
Item22
Item23
Item25

Looking at the pattern of the result, most of the items are very easy because their standard deviation fell below zero. Out of the 60 items only items 17, 32, 37, 38, 39, 48 and 55 (just about 11.67% of the total items) showed standard deviation of more than zero when administered on urban JSS 3 students. The pattern of result from the rural students examined also showed that 11 items (items 5, 6, 8, 11, 20, 26, 37, 39, 48, 55 and 58) have difficulty indices above zero out of the 60 item, representing about 18.33%. From this result the urban JSS3 students has better chance of passing when compared to their counterparts in the rural areas.

In comparison, 39 items (1, 2,3, 4, 5, 6, 7, 8, 9, 11, 14, 15, 16, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 33, 34, 35, 36, 39, 42, 43, 44, 45, 46, 49, 53, 58 and 59) were found to be easier for the urban JSS3 students while 21 items (10, 12, 13, 17, 22, 31, 32, 37, 38, 40, 44, 47, 48, 50, 51, 52, 54, 55, 56, 57, and 60) were also found to be easier for the rural subgroup.

Discrimination parameter is an index that shows how good an item is in classifying examinees either below or above the difficulty parameter of an item. Normally an index of 1.00 is ideal. Items having indices greater than 1.00 are better but less than 1.00 are not good discriminators. On separate administration of the instrument to both urban and rural JSS3 students and after analysis, varying discrimination indices were obtained ranging from negative to positive values. Out of the 60 items administered the urban students 28 items (4, 8, 9, 10, 11, 13, 14, 17, 22, 32, 33, 37, 38, 39, 40, 41, 52, 53, 54, 55, 56, 57 and 58) had negative discrimination indices while the rest had positive indices. After administering to the rural student it was also found that 23 items (4, 5, 6, 8, 9, 10, 13, 14, 18, 22, 26, 32, 33, 37, 39, 40, 41, 52, 53, 54, 55, 56 and 57) had negative discrimination indices.

DISCUSSION

From the results of the analyses, both groups of students responded to the 2019 BECE basic science items. It was found that each of the items had differing difficulty indices as the two subgroup of students were measured. The results showed that rural students encountered more difficult items (11) than their urban counterparts who had only seven (7) items out of 60. The remaining items with standard deviation less than zero also showed differential difficulty indices between the two groups examined.

It was also discovered that all the items varied in discrimination indices between the two groups examined. Some values were positive while others were negative. In the urban students' assessment, 28 items had negative value while in the rural students', 23 items were found to have negative value out of 60 items. Items with negative discrimination indices are not good discriminations.

The sensitivity of DIF detection method varies among the multitude available. In this study, the Mantel-Haenszel (M-H) method was used. The M-H method has the ability to detect uniform DIF without using item response approach (Holland & Thayer, 1988). The M-H DIF analysis result showed each item's value (chi-square statistic and corresponding P-value). A total of six items (items 5, 12, 21, 22, 23, and 25) were flagged as DIF items. Based on the presence of the six DIF items, the null hypothesis was rejected.

CONCLUSION AND RECOMMENDATION

From the findings of the study, items of the 2019 basic science BECE exhibited DIF when used during examination. This test was slightly easier for urban students and more difficult for rural students. In the light of this finding, it is recommended that before such and similar test items are used to assessment, thorough

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investigation of items be conducted for possible DIF. If any item is flagged as DIF, it should be edited or eliminated to ensure the right quality instrument is designed and used. The same learning experiences should be provided for all JSS3 students across the state, as against the preferences enjoyed by the urban students.

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